

REMARKS

By the present amendment, claims 3-6 and 16-17 are pending in the application. Claims 16 and 17 are the independent claims.

Support For Claim Amendments

Independent claims 16 and 17 have been amended at the end of each claim to specify that the metal balls are contacting a respective electrode.

Independent claims 16 and 17, prior to the amendment, each required, and still require, that the metal balls are “adhesive bonded to and contacted with the electrodes (8)”.

With reference to the preferred embodiment of the present invention disclosed at page 10, line 32 to page 11, line 2 of the specification and illustrated in Fig. 6B, it is stated specifically at page 10, line 37 to page 11, line 2 that “The arrangement base plate is then moved downward so that the solder balls 53 are contacted with the respective electrodes 52.” (Emphasis added).

That is, the downward movement of the arrangement base plate forces the metal balls 53 through the flux so that the metal balls 53 contact the respective electrode.

The present invention is illustrated in the lower figure of Attachment A which is attached hereto.

In Webster’s New Collegiate Dictionary 150th Anniversary Edition (1981) the first definition of the word **contact** is:

Contact – 1a: union or junction of surfaces.

Metal balls in contact (union or junction of surfaces) with the electrodes are clearly illustrated in Figs. 2, 4c, 5 and 6b of the drawings of the specification of the present

application. Note that the metal balls contacting the electrodes in Figs. 2, 4c, 5 and 6b have a spherical shape and thus have not been reflowed.

§103

Claims 16 and 17 were rejected under 35 U.S.C. §103(a) as being unpatentable over Japan No. 06-333930 to Matsumoto in view of Japan No. 63-117450 to Okuaki and U.S. Patent No. 5,470,787 to Greer.

Claims 3-6 were rejected under 35 U.S.C. §103(a) as being unpatentable over Japan No. 06-333930 to Matsumoto in view of Japan No. 63-117450 to Okuaki and U.S. Patent No. 5,470,787 to Greer and further in view of U.S. Patent No. 5,656,863 to Yasunaga et al.

These rejections, as applied to the amended claims, are respectfully traversed.

Patentability

The present invention is directed to a semiconductor device in which spherical metal balls are adhesive bonded to and contacted with the electrodes of the device, as seen in the lower figure of the attached Attachment A. Flux has, in general, a high viscosity and allows the metal ball to be securely held on the electrode and to be securely in contact therewith.

The device of the present invention ensures that the metal balls are subsequently reflowed in place (i.e., just on the electrodes) to form bumps to be used for the bonding with an object, such as a mounting substrate. If metal balls, which are not in contact with the electrodes, are reflowed, the metal balls are melted in a condition wherein the metal floats on the flux which results in insufficient contact of the subsequently formed bumps with the electrodes.

Matsumoto (JP 6-333930), cited by the Office Action, discloses a method for adhering solder balls to electrodes using flux, and describes a solder ball 6 adhering to each pad 2 due to flux (English abstract). According to Matsumoto, by tilting a wafer having electrodes with flux leftward and rightward, the solder balls are rolled on the face of the wafer on which the electrodes are provided, and are caught by the flux so as to be coupled with the electrodes.

However, the tilting of the wafer does not permit the balls to intrude into the flux to thereby establish contact of the balls with the electrodes. Such contact can be established only when an arrangement base plate, on which the metal balls are held, is moved downward so that the metal balls penetrate the flux on the electrodes and are contacted with the electrodes.

As such, Matsumoto does not disclose a technology for producing a semiconductor device having the feature: “the metal balls intruding into the flux and contacting a respective electrode”, as required by amended independent claims 16 and 17.

The metal balls of Matsumoto are not in **contact** with the electrodes. See prior discussion of the definition of **contact**.

The technology of Matsumoto is illustrated in the upper figure in attached Attachment A. The metal balls of this technology are very small and very light and do not penetrate the flux of Matsumoto and contact the electrodes of Matsumoto by tilting the wafer leftward and rightward.

If the metal balls of Matsumoto are reflowed, the melted metal flows on the flux and do not fully wet the electrodes.

As such, in Matsumoto, flux is used to catch and hold the rolled metal balls and does not result in the balls coming into contact with the electrodes. In the present

invention, flux is used to keep the metal balls mounted on the electrodes in contact with the electrodes. Such use of flux in the present invention is neither disclosed nor suggested in Matsumoto.

The cited Okuaki and Greer references do not cure the lack of disclosure in Matsumoto.

Okuaki (JP 63-117450A) relates to a method for providing reflowed bump electrodes having a uniform height. The method of Okuaki is directed to the mounting of a semiconductor device on the film carrier (TAB, Tape Automated Bonding), as referred to on the first page, the right column, lines 9 to 11. In Okuaki, the bump used is not spherical, and a flux is applied onto the bump (page 3, the upper right column, lines 13 to 16), and not to adhesive bond the bump and a semiconductor chip on which the bump is formed. The flux in Okuaki does not adhesive bond the bump to the semiconductor chip.

In the case of the present invention, the metal ball has not yet been reflowed and melted. The metal ball of the present invention, which is not reflowed, is adhesive bonded to the electrode with the flux and in contact with the respective electrode.

Greer uses evaporation for the formation of bumps. The bump becomes a dome-like (ball-like) shape after reflowing. The bump of Greer is not bonded to an electrode with a flux and held in contact with the electrode. Thus, the technical idea of Greer is totally different from the present invention.

It is therefore submitted that the invention of independent claims 16 and 17 of the present application is not disclosed or suggested to a person of skill in the art from the disclosures of these references cited by the Office Action.

It is therefore submitted that independent claims 16 and 17 are patentable over Matsumoto in view of Okuaki and Greer.

Since independent claims 16 and 17 are patentable, dependent claims 3 to 6 are also patentable.

CONCLUSION

It is submitted that in view of the present amendment and foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the application, as amended, be allowed and passed for issue.

Respectfully submitted,

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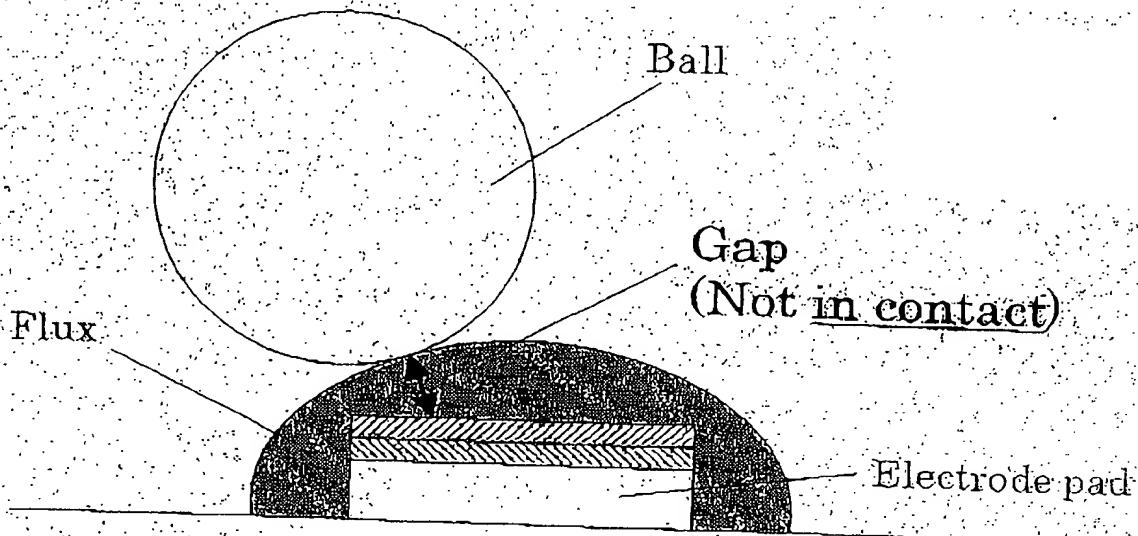
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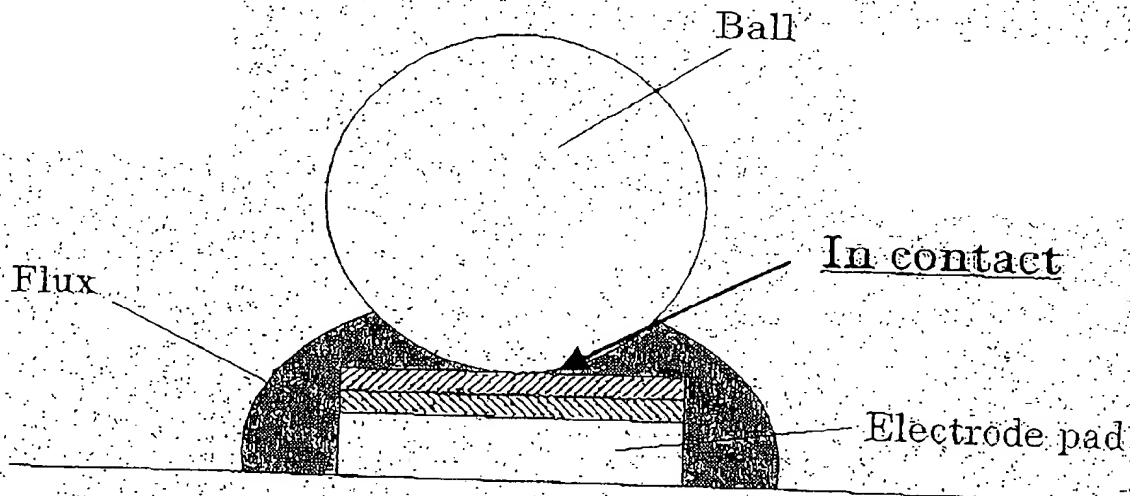
ATTACHMENT A



MATSUMOTO - No contact of ball with electrode



THE INVENTION - Ball in contact with electrode



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